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~~The purpose of this~~ working paper is to describe the environmental conditions which will be modeled in the Military Worth evaluation and to specify at what environmental conditions the performance of the point design should be presented in the point design report. In evaluating the performance of a point design, the following environmental parameters will be considered: (1) Sea state as defined by the wave height and encounter frequency, (2) wind conditions associated with each sea state as defined by the velocity as a function of altitude, (3) air conditions as defined by air temperature,

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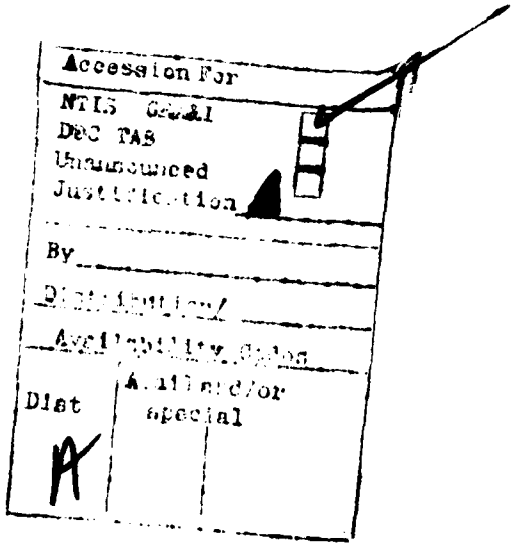
pressure, density and viscosity as a function of altitude, and (4) water conditions as defined by water temperature, density and viscosity as a function of depth.



ADVANCED NAVAL VEHICLES CONCEPTS EVALUATION

(6) ENVIRONMENTAL CONDITIONS FOR (ANVCE) MILITARY WORTH MODEL,

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I. INTRODUCTION

In order to evaluate the Military Worth of the ANVCE point designs, the environmental conditions must be specified for each of the twelve operations. The purpose of this working paper is to describe the environmental conditions which will be modeled in the Military Worth evaluation and to specify at what environmental conditions the performance of the point design should be presented in the point design report.

II. ENVIRONMENTAL PARAMETERS

In evaluating the performance of a point design, the following environmental parameters will be considered:

- Sea state as defined by the wave height and encounter frequency,
- Wind conditions associated with each sea state as defined by the velocity as a function of altitude,
- Air conditions as defined by air temperature, pressure, density and viscosity as a function of altitude,
- Water conditions as defined by water temperature, density and viscosity as a function of depth.

These parameters are specified for the North Atlantic in Appendix A. Environmental data will be provided for the other geographic locations to be considered in the Military Worth Evaluation in subsequent issues of this working paper. These parameters will be input to the military worth model in order to determine the impact of the environment on the

vehicle's mobility performance (speed, range and maneuverability) and crew and combat system performance as affected by the ride quality.

III. SPECIFIC ENVIRONMENTAL CONDITIONS TO BE REPORTED IN POINT DESIGN

Working Paper 005A of 13 August 1976, which describes the content and format for the ANVCE point design reports, specifies that vehicle performance (drag, thrust, speed, turning radius and rate, fuel consumption and range, and vertical and lateral accelerations) will be presented as a function of environmental conditions (primarily significant wave height). This performance data will be stated in head seas at the following four conditions:

Sea State	Significant Wave Height, $H_{1/3}$ ft	m	Associated Wind Speed in Knots [1/]
0	0.0	0.0	0
3	4.6	1.4	10
6	15.0	4.57	38
8[2/]	50.0	15.24	67

1/ Wind speed at an elevation of 30 ft (9.14m)
2/ For survival mode and configuration only.

In addition,for air vehicles the speed and maneuverability is to be presented as a function of altitude. (When the gross operating characteristics of the air point designs have been identified, the specific altitudes at which performance is to be presented will be specified.

APPENDIX A

ENVIRONMENTAL CONDITIONS IN NORTH ATLANTIC

For the purpose of the ANVCE Military Worth Evaluation, the environmental condition in the North Atlantic is defined as follows:

1. Sea State

In order to provide a common basis for comparison it will be assumed that each sea state will be represented by a single wave spectrum and that the total probability of occurrence of each sea state will be as defined in Table 1. For all calculations it will be assumed that the principal direction of sea state propagation and surface wind directions are the same. The performance of the vehicle will be calculated in head seas.

It has been decided that the Pierson-Moskowitz family of wave spectra will be adopted to define each sea state although it is well known that this representation is not well suited to simulating swell conditions or very high sea states. The Pierson-Moskowitz spectra, however, are in general use; most model test tanks are set up to generate waves in this form and a great deal of information is available about the behavior of various vehicles in model scale waves generated in this way. For similar reasons a two-dimensional (long-crested) representation of ocean waves will be specified as this will more readily facilitate the use of model test results and less complex analytical representations.

The Pierson-Moskowitz (single parameter) spectrum is defined as follows:

$$S(\omega) = (8.1 \times 10^{-3}) g^2 \omega^{-5} e^{-.74\left(\frac{\omega_o}{\omega}\right)^4}, \frac{ft^2}{Rad/sec} \qquad (1)$$

Where $S(\omega)$ = energy spectrum

$\omega_o = \sqrt{0.21g/H_{1/3}}$ radians/second

ω = $2\pi f$ = circular frequency, rad/sec

f = wave encounter frequency as seen by a stationary observer

$H_{1/3}$ = The significant wave height, ft

Note that the typical solutions to equation (1), presented in Figure 1, are in terms of cyclic frequency (f), cycles per second, as opposed to circular frequency (ω) radians/second (i.e., S(f) is shown as a function of (f)).

2. Wind Conditions

Standard wind speeds and their probability of occurrence will be selected from those defined in Table 1. The probability data for winds of varying strength given in Table 1 are for winds that are assumed to exist at an elevation of 30 ft (9.14 m) above the mean sea surface. Wind speeds, on a given day, will however vary considerably with altitude. For point designs evolved in near surface operation (less than 100 ft or 30 m above the mean sea surface) a factor derived from the wind gradient curve of Figure 2 will apply to the wind speeds (of given probability) presented in Table 1.

3. Air Condition

All performance data will be quoted for conditions defined by the International Standard Atmosphere (ISA) as shown in Table 2.

4. Water Conditions

Performance will be quoted for the standard water conditions specified in Table 3. (The variation of these conditions as a function of depth will be provided at a later date.)

Table 1

SIMPLIFIED SEA STATE DEFINITIONS

Sea State	Significant Wave Height, $H_{1/3}$ ft	m	Percentage Occurrence (%) 1/	Associated Wind Speed in Knots 2/
0	0.0	0.0	0	0
1	0.60	0.18	5.0	2
2	2.2	0.67	13.5	6
3	4.6	1.40	26.0	10
4	6.9	2.10	27.0	16
5	10.0	3.05	20.0	26
6	15.0	4.57	7.0	38
7	30.0	9.14	1.97	53
8	50.0	15.24	0.03	67

1/ Percentage of total time at sea
2/ Wind speed at an elevation 30 ft (9.14 m) above mean sea surface. See Figure 2 for conversion to elevations other than 30 ft.

Table 2

STANDARD ATMOSPHERE

Altitude Above Sea Level		Temperature		Pressure		Density		Kinematic Viscosity	
Ft	m	°F	°C	(lb/ft^2) abs	N/m^2	Slugs $/Ft^3$	Kg/m^3	$1x10^{-4}$ Ft^2/sec	$1x10^{-5} m^2/sec$
0	0	59	15	2116.2	101.32	0.002378	1.226	1.564	1.453
1000	305	55.44	13.02	2040.9	97.719	0.002310	1.191	1.602	1.488
2000	610	51.87	11.04	1967.7	94.214	0.002242	1.155	1.641	1.524
3000	914	48.31	9.06	1896.7	90.814	0.002177	1.122	1.681	1.562
4000	1219	44.74	7.08	1827.7	87.510	0.002112	1.088	1.723	1.601
5000	1524	41.18	5.10	1760.8	84.307	0.002049	1.056	1.766	1.641
10000	3048	23.36	-4.80	1455.4	69.685	0.001756	0.905	2.002	1.860
15000	4572	5.54	-14.70	1194.3	57.183	0.001497	0.7715	2.280	2.118
20000	6096	-12.28	-24.60	972.6	46.568	0.001267	0.6322	2.608	2.423
25000	7620	-30.10	-34.50	785.3	37.600	0.001066	0.549	2.999	2.786

Table 3

STANDARD WATER
(SALT WATER)

Property	British Units	Metric Units
Temperature	59° F	15°C
Weight density w	64.04 lb/ft^3	1028 kg/m^3
Kinematic Viscosity (μ/ρ)	1.282 x 10^{-5} ft^2/sec	0.119 x 10^{-5} m^2/sec

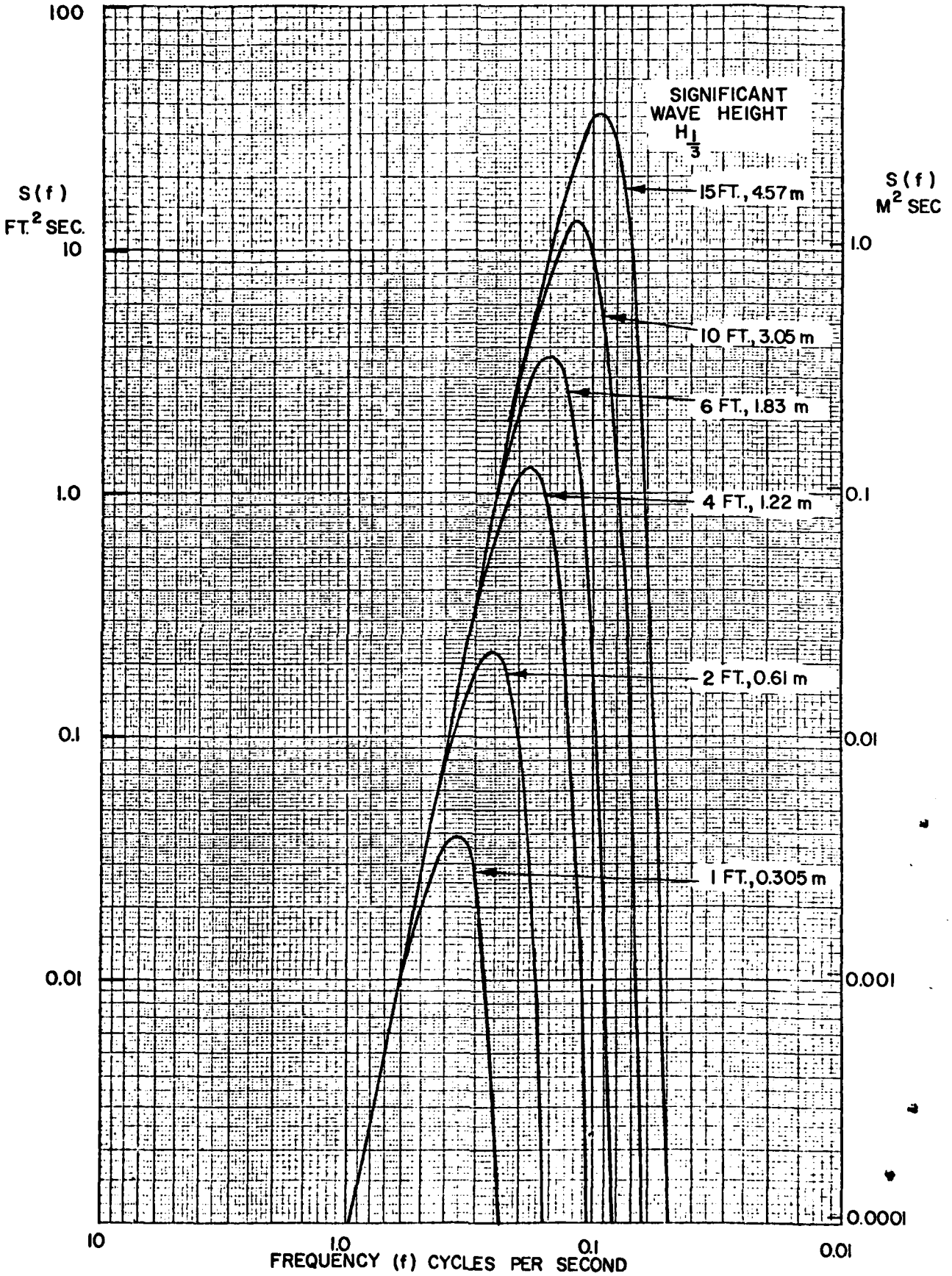
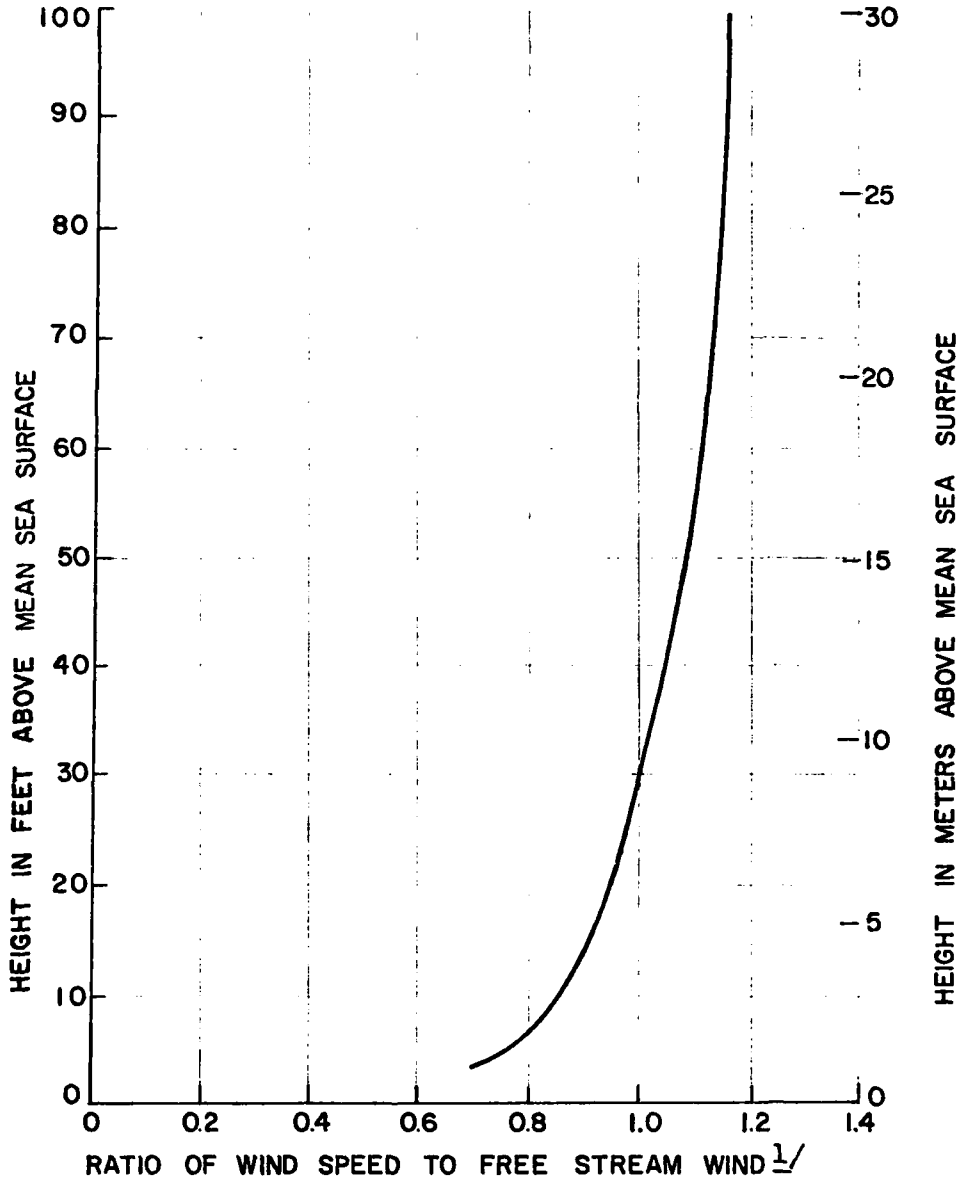


Figure 1. Pierson-Moskowitz Sea Spectrum.



1/ Free stream at 30 ft (9.144 m) above mean sea surface.

Figure 2. Wind Gradient Above Sea Surface.